

Serial No. 10/783,499

Docket No. Zipfel 1

RECEIVED
CENTRAL FAX CENTER

DEC 10 2007

CLAIMS

1

2 1. (Currently Amended) Apparatus comprising
3 at least first and second reactive loads,
4 means for generating first and second switching signals each having respective
5 switching band components and at least one respective baseband component, and
6 means for applying said first and second switching signals to said first and second
7 reactive loads, respectively,
8 the means for generating generating the switching signals in such a way, and the
9 means for applying applying the first and second switching signals to the first and second
10 reactive loads in such a way that a) the sum of the values of the instantaneous currents
11 through said each load is substantially constant zero, b) substantially all of said at least
12 one baseband component of said first switching signal is a current that flows into said
13 first reactive load and c) substantially all of said at least one baseband component of said
14 second switching signal is a current that flows into said second reactive load,
15 wherein at least one of said reactive loads is a transducer.

2. Canceled.

1 3. (Previously Presented) The invention of claim 1 wherein there are N of
2 said loads and wherein for each of a number of signal variables for each load, the sum of
3 the values of each particular signal variable is substantially constant.

1 4. (Original) The invention of claim 3 wherein said number of signal
2 variables is greater than 1 and less than N.

1 5. (Previously Presented) The invention of claim 1 wherein respective first
2 terminals of each of said loads are connected to a common node through which said
3 current at baseband frequencies flows, said common node being connected to a fixed
4 potential.

Serial No. 10/783,499

Docket No. Zipfel 1

1 6. (Previously Presented) The invention of claim 5 wherein each of said
2 loads has a second terminal and wherein said apparatus further comprises means for
3 applying at least the baseband components of said first switching signal between the
4 second terminal of said first load and said common node and for applying at least the
5 baseband components of said second switching signal between the second terminal of
6 said second load and said common node.

1 7. (Previously Presented) The invention of claim 1 further comprising a
2 mechanical load connected to said transducer.

1 8. (Original) The invention of claim 7 wherein said mechanical load
2 includes means for generating acoustic sonar signals.

1 9. (Currently Amended) Apparatus comprising
2 at least first and second reactive loads,
3 means for generating at least first and second switching signals, each having
4 respective switching band components and at least one respective baseband component,
5 means for applying said first and second switching signals to said first and second
6 reactive loads, respectively,
7 the means for generating and the means for applying causing a) substantially all
8 of the same amount of current at baseband frequencies that flows out of one or more of
9 said loads at a given time to flow into one or more of the others of said loads, b)
10 substantially all of said at least one baseband component of said first switching signal to
11 be a current that flows into said first reactive load and c) substantially all of said at least
12 one baseband component of said second switching signal to be a current that flows into
13 said second reactive load,
14 wherein at least one of said reactive loads is a transducer.

1 10. (Previously Presented) The invention of claim 9 further comprising
2 means for connecting respective first terminals of each of said loads to a common power
3 supply node through which said current at baseband frequencies flows.

Serial No. 10/783,499

Docket No. Zipfel 1

1 11. (Previously Presented) The invention of claim 10 wherein each of said
2 loads has a second terminal and wherein said apparatus further comprises means for
3 applying at least the baseband components of said first switching signal between the
4 second terminal of said first load and said common node and for applying at least the
5 baseband components of said second switching signal between the second terminal of
6 said second load and said common node.

1 12. (Withdrawn-Previously Presented) The invention of claim 11 wherein
2 said switching amplifier is further adapted to drive a third reactive load with a third
3 switching signal, said third switching signal having switching band components and at
4 least one baseband component, said third load having a second terminal, and wherein said
5 switching amplifier further comprises means for applying the at least one baseband
6 component of said third switching signal between the second terminal of said third load
7 and said common node.

1 13. (Original) The invention of claim 9 wherein said loads have
2 substantially equal impedance and wherein said baseband components are the inverse of
3 one another.

1 14. (Previously Presented) The invention of claim 9 wherein said apparatus
2 further includes at least one power supply terminal and wherein said current flowing out
3 of one or more of said loads flows away from said power supply terminal and said current
4 flowing into one or more of the others of said loads flows toward said power supply
5 terminal.

1 15. (Original) The invention of claim 14 wherein the phases and amplitudes
2 of said baseband components are such that said currents add to zero at substantially all
3 times.

Serial No. 10/783,499

Docket No. Zipfel 1

1 16. (Previously Presented) The invention of claim 14 wherein respective
2 first terminals of each of said loads are connected to a common node through which said
3 current at baseband frequencies flows, said common node being at a fixed potential.

1 17. (Original) The invention of claim 9 wherein there are two of said loads,
2 wherein said two loads have substantially equal impedances and wherein the baseband
3 components of said first and second switching signals are of substantially equal
4 magnitude and are substantially the inverse of one another.

1 18. (Withdrawn) The invention of claim 9 wherein said switching amplifier
2 is further adapted to drive a third reactive load with a third switching signal, wherein said
3 first, second and third loads have substantially equal impedances and wherein the
4 baseband components of said first, second and third switching signals are such that they
5 add to zero at substantially all times.

1 19. (Previously Presented) The invention of claim 9 further comprising a
2 mechanical load connected to said transducer.

1 20. (Original) The invention of claim 19 wherein said mechanical load
2 includes means for generating acoustic sonar signals.

1 21. (Previously Presented) The invention of claim 9 wherein said apparatus
2 further includes at least first and second signal paths containing said first and second
3 loads, respectively.

1 22. (Original) The invention of claim 21 wherein alternating polarity
2 currents flow in said first and second signal paths in response to said first and second
3 switching signals, respectively.

Serial No. 10/783,499

Docket No. Zipfel 1

1 23. (Original) The invention of claim 22 wherein said first and second
2 switching signals are generated in response to first and second pulse-width-modulated
3 signals, respectively.

1 24. (Previously Presented) The invention of claim 21 wherein said apparatus
2 further includes means for applying said first and second switching signals to said first
3 and second signal paths, respectively, in such a way that at least one switching band
4 component of said first switching signal and at least one switching band component of
5 said second switching signal cancel each other and therefore are substantially isolated
6 from said loads.

1 25. (Original) The invention of claim 24 wherein alternating polarity
2 currents flow in said first signal path in response to said first switching signal and
3 alternating polarity currents flow in said second signal path in response to said second
4 switching signal.

1 26. (Currently Amended) The invention of claim 24 wherein
2 said at least one switching band component of said first switching signal and said
3 at least one switching band component of said second switching signal are the
4 fundamental frequency components of said first and second switching signals,
5 respectively, and are of substantially the same amplitude and phase, and
6 said means for applying comprises a common-mode inductor in said first and
7 second signal paths.

1 27. (Withdrawn) The invention of claim 21 wherein said switching amplifier
2 is further adapted to drive a third reactive load with a third switching signal, wherein said
3 switching amplifier includes at least a third signal path containing said third load, and
4 wherein said switching amplifier further includes means for applying said first, second
5 and third switching signals to said first, second and third signal paths, respectively, in
6 such a way that at least one switching band component of each of said first, second and

Serial No. 10/783,499

Docket No. Zipfel I

7 third switching signals cancel each other and therefore are substantially isolated from said
8 loads.

1 28. (Withdrawn) The invention of claim 27 wherein alternating polarity
2 currents flow in said first signal path in response to said first switching signal, alternating
3 polarity currents flow in said second signal path in response to said second switching
4 signal, and alternating polarity currents flow in said third signal path in response to said
5 third switching signal.

1 29. (Withdrawn) The invention of claim 27 wherein
2 said at least one switching band component of said first, second and third
3 switching signals are of substantially the same amplitude and phase, and
4 said means for applying comprises a common-mode inductor in said first, second
5 and third signal paths.

1 30. (Previously Presented) The invention of claim 21 wherein
2 each of said loads includes a first terminal and a second terminal,
3 the first terminals of each of said loads are connected to a common node through
4 which said current at baseband frequencies flows, said common node being adapted to be
5 connected to a fixed potential,
6 each said path includes filtering circuitry connected to the second terminal of the
7 respective load, and
8 each of said first and second switching signals comprises an alternating polarity
9 signal impressed across said first and second signal paths, respectively.

1 31. (Original) The invention of claim 21 wherein
2 each of said loads includes a first terminal and a second terminal,
3 the first terminals of each of said loads are connected to a common node through
4 which said current at baseband frequencies flows, said common node being connected to
5 a fixed potential,

Serial No. 10/783,499

Docket No. Zipfel 1

6 each said path includes filtering circuitry connected to the second terminal of the
7 respective load, and

8 said first and second switching signals comprise respective signals at first and
9 second potentials applied to the filtering circuitry of said first and second signal paths,
10 respectively.

1 32. (Original) The invention of claim 31 wherein
2 said second potential is substantially equal to said fixed potential, and
3 said filtering circuitry includes at least one energy storage element that stores
4 energy when each said switching signal is at said first potential and that supplies energy
5 to said loads when each said second node is connected to said second potential.

1 33. (Currently Amended) The invention of claim 32 wherein
2 said energy storage element is a common-mode inductor having first and second
3 ports in said first and second paths, respectively, and
4 said first and second switching signals have respective fundamental switching
5 band components that are of substantially equal magnitude and phase that are canceled by
6 said common-mode inductor.

1 34. (Currently Amended) Apparatus comprising
2 two or more circuit paths each including a respective reactive load, each of said
3 loads having a first terminal connected to the first terminal of each other load, at least one
4 of said loads being a transducer,
5 means for generating for each of said circuit paths an associated pulse-width-
6 modulated signal, each pulse-width-modulated signal alternating between a respective
7 first level and a respective second level at a particular switching frequency, the pulse
8 widths of the pulses of each pulse-width-modulated signal being determined by a
9 respective baseband signal,
10 means responsive to each of said pulse-width-modulated signals for impressing an
11 associated switching signal across the associated circuit path, said switching signal

Serial No. 10/783,499

Docket No. Zipfel I

12 comprising first and second voltages impressed across the associated circuit path when
13 the associated pulse-width-modulated signal is at its first and second levels, respectively,
14 the baseband signals being such that substantially ~~all~~ of the same amount of current at baseband frequencies flowing out of one or more of said loads at a given time
15 flows into one or more of the others of said loads, and such that substantially all of the
16 current at baseband frequencies flowing in said two or more circuit paths flows through
17 the respective reactive load.

1 35. (Original) The invention of claim 34 wherein there are N of said circuit
2 paths and wherein the phase of each of the baseband signals differs from the phase of one
3 other of said baseband signals by $360/N$ degrees.

1 36. (Original) The invention of claim 34 wherein said circuit paths include
2 circuitry in common that prevents current at at least said switching frequency from
3 flowing through said loads.

1 37. (Original) The invention of claim 34 wherein said circuit paths include
2 in common circuitry that isolates signals at at least said switching frequency from said
3 loads.

1 38. (Original) The invention of claim 34 wherein said circuit paths include
2 in common circuitry that cancels signals at at least said switching frequency.

1 39. (Original) The invention of claim 34 wherein said switching signals are
2 in phase with one another at said switching frequency and wherein said circuit paths
3 include respective ports of a common-mode inductor that cancels signals at at least said
4 switching frequency, thereby preventing most of the energy in said switching signals at
5 said switching frequency from being applied to said loads.

1 40. (Withdrawn) The invention of claim 39 wherein $N \geq 3$.

Serial No. 10/783,499

Docket No. Zipfel 1

1 41. (Previously Presented) The invention of claim 34 further comprising a
2 mechanical load connected to said transducer.

1 42. (Original) The invention of claim 41 wherein said mechanical load
2 includes means for generating acoustic sonar signals.

43 – 51. Canceled.

1 52. (Withdrawn-Previously Presented) Apparatus comprising
2 means for generating at least first and second switching signals having the same
3 switching frequency and having respective fundamental frequency components that have
4 a particular phase relationship with one another and said first and second switching
5 signals having respective baseband components at at least one baseband frequency that
6 do not have said particular phase relationship with one another,

7 at least first and second reactive loads, at least one of said loads being a
8 transducer,

9 a rejection filter that cancels signals applied to respective ports thereof that have
10 said predetermined phase relationship, and

11 means for applying said at least first and second switching signals to respective
12 circuit paths that include said at least first and second loads, respectively, and that include
13 respective ports of said rejection filter, whereby signals at said fundamental switching
14 frequency are isolated from said loads while said baseband components at at least said
15 one baseband frequency are applied to said loads,

16 wherein substantially all of the baseband component of said first switching signal
17 at said at least one baseband frequency is a current that flows into said first reactive load
18 and substantially all of the baseband component of said second switching signal at said at
19 least one baseband frequency is a current that flows into said second reactive load..

1 53. (Withdrawn) The invention of claim 52 wherein said fundamental
2 frequency components are in phase with one another, said baseband components are the
3 inverse of one another, and said rejection filter is a common-mode inductor.

Serial No. 10/783,499

Docket No. Zipfel 1

1 54. (Withdrawn) The invention of claim 52 wherein
2 said at least first and second switching signals comprises at least first, second and
3 third switching signals,
4 said apparatus further comprises a third reactive load, and
5 said apparatus further comprises means for applying said third switching signal to
6 a respective circuit path that includes said third load and that includes a respective port of
7 said rejection filter.

1 55. (Withdrawn) The invention of claim 54 wherein said rejection filter is a
2 common-mode inductor.

1 56. (Withdrawn) The invention of claim 52 wherein said rejection filter is a
2 common-mode filter, wherein said switching signals are phased in such a way that, and
3 are applied to said common-mode filter in such a way that, said fundamental frequency
4 components comprise a common-mode input signal for said common-mode filter and
5 said baseband components are differential mode signals for said common-mode filter.

1 57. (Withdrawn-Previously Presented) The invention of claim 56 wherein a
2 mechanical load is connected to said transducer.

1 58. (Withdrawn-Previously Presented) The invention of claim 57 wherein
2 said mechanical load includes means for generating acoustic sonar signals.

59-62. Canceled.

1 63. (Currently Amended) A switching amplifier operating at a particular
2 switching frequency, the switching amplifier comprising
3 at least first and second circuit paths,
4 each of said paths comprising switching circuitry, a load filter, a respective port of
5 a common-mode inductor and a transducer, all connected in series, each transducer
6 having a terminal that is connected to a power supply node in common with each other

Serial No. 10/783,499

Docket No. Zipfel 1

7 transducer, each load filter having a passband that includes said particular switching
8 frequency and having a stop band at frequencies higher than said particular switching
9 frequency,
10 said switching circuitry being operative in response to a first pulse-width-
11 modulated signal to cause first and second voltages of a first switching signal to be
12 alternately impressed between the load filter of said first circuit path and said common
13 node and being further operative in response to a second pulse-width-modulated signal to
14 cause first and second voltages of a second switching signal to be alternately impressed
15 between the load filter of said second circuit path and said common node,
16 said first and second switching signals having respective fundamental switching
17 components that are of substantially equal magnitude and phase so that they are canceled
18 by said common-mode inductor, said first and second switching signals each further
19 having at least one respective baseband component, the baseband components of said
20 first and second switching signals being such that substantially all of the same amount of
21 current at baseband frequencies flowing out of one or more of said transducers at a given
22 time flows into one or more of the others of said loads, and
23 substantially all of said at least one baseband component of said first switching
24 signal being a current that flows into one of said transducers and substantially all of said
25 at least one baseband component of said second switching signal being a current that
26 flows into another of said transducers.

1 64. (Original) The invention of claim 63 wherein the phases and amplitudes
2 of said baseband components are such that said currents add to zero at substantially all
3 times.

1 65. (Previously Presented) The invention of claim 63 wherein said
2 transducers have substantially equal impedance and wherein said baseband components
3 are the inverse of one another.

1 66. (Previously Presented) The invention of claim 63 wherein said switching
2 amplifier includes at least one power supply terminal and wherein said current flowing

Serial No. 10/783,499

Docket No. Zipfel 1

3 out of one or more of said transducers flows away from said power supply terminal and
4 said current flowing into one or more of the others of said transducers flows toward said
5 power supply terminal.

1 67. (Previously Presented) The invention of claim 63 wherein there are two
2 of said transducers having substantially equal impedances and wherein the baseband
3 components of said first and second switching signals are of substantially equal
4 magnitude and are substantially the inverse of one another.

1 68. (Previously Presented) The invention of claim 67 wherein a mechanical
2 load is connected to at least one of said transducers.

1 69. (Original) The invention of claim 68 wherein said mechanical load
2 includes means for generating acoustic sonar signals.

70 - 78. Canceled